APPENDIX B:

ESTIMATION OF SOIL VAPOR PATHWAY REL

The Johnson and Ettinger vapor model (SL-ADV, Version 3.0) was completed to determine the risk-based soil concentration expected to result in an acceptable level of human inhalation risk from soil vapor intrusion impacts on new site development. The following presents the input data used, assumptions made, and the resulting risk calculations.

Model risk calculations were performed assuming the contaminated layer underlies the entire building footprint.

Soil physical parameters have not been analytically tested, so the pertinent default model values for observed soil types were used. Soils beneath the site have been described in previous investigations as sands and silty sands. Sand was used as the soil type based on these previous investigations and on anticipated backfill material, as a conservative scenario.

The average soil temperature input value was obtained from the J&E user manual (p. 48 = assume 53 degrees F = 12 degrees C).

The depths to the top and bottom of the contaminated zone were based on previous field investigation observations and analytical data. Modeling was completed assuming the contaminated zone extends from 1.0 to 7.0 feet bgs.

Since final design drawings for the future museum have been provided, building dimension information was assumed from the site plan provided by the Historical Society, and is for estimation purposes only. From the drawing provided, the following model input values were used:

Enclosed space floor width = 72 ft = 2195 cm
Enclosed space floor length = 25 ft = 762 cm
Assume lowest possible ceiling height of 10 feet = 30.48 cm

The depth below grade of the enclosed floor space and enclosed space floor thickness values were assumed to be 0.5 feet, standard for a slab on grade construction.

MTCA standard exposure assumptions were used as model input for exposure duration and averaging times for carcinogens and noncarcinogens (WAC 173-340-750).

Johnson and Ettinger default values for floor wall crack seam width of 0.1 cm and the model default value for differential pressure were used.

A reasonable maximum exposure frequency was calculated assuming an individual who worked in the museum spent 8 hours per day, 5 days per week, and 52 weeks per year inside the museum building. This calculates to 87 (24-hour) days per year.

The final model input affecting the risk to human health is the indoor air exchange rate. Without details from the final building construction design, the air exchange rate inside the museum was calculated using WAC Chapter 51-13-304 ventilation requirements for library spaces. Based on the assumed building size, this results in an indoor air exchange rate of 1.8 exchanges / hour.

The Model was used to back-calculate a soil concentration resulting in an acceptable incremental risk level of $1.0E^{-06}$. This concentration is 0.065 mg/kg.

DATA ENTRY SHEET

SL-ADV Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. belo

YES X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemica
71432	6.50E+01	Benzene

MORE

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
12	15	30.48	213.36	30.48	0	0	S		

MORE

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
S	1.66	0.375	0.054	0.002										

MORE

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	762	2195	30.48	0.1	1.8	

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
75	6	30	87	1.0E-06	1
				Used to calculate risk-based soil concentration.	

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	3.13E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.0E-06	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END